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An empirical investigation of barriers, drivers and practices for energy efficiency in primary metals manufacturing SMEs

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Abstract

Despite the well-known need for increased industrial energy efficiency, several studies indicate that energy efficiency measures are little implemented, especially in Small and Medium-sized Enterprises (SMEs). Therefore, to sustain the development of the effective policies, a better understanding of the barriers to be tackled and the drivers to be promoted is crucial. To do so, we have performed an investigation within 64 primary metal manufacturing SMEs located in a Northern Italy province. The adoption of energy management practices among the sample is scarce: indeed, consumption monitoring, energy data analysis, programs of staff training and motivation are barely implemented. The analysis highlights the relevance of economic and information barriers, suggesting that, beside the issue of capital availability, information about technology, regulations and opportunities for financing are perceived as complicated, fragmented or not trustworthy, especially those coming from government and financial institutions. Moreover, barriers affect mostly the first steps of the decision-making process, i.e. those related to the awareness and identification of the punctual measure to be adopted. With exception of smaller firms, start-up and training are not perceived as critical. All external drivers are perceived as more relevant than internal ones. Nonetheless, beside the primary role of economic drivers, the study shows that SMEs look also for increased information on energy efficiency solutions, with greater role played by their energy suppliers, manufacturers and technology suppliers. Finally, particular relevance is given to training, suggesting that greater attention should be paid in the increased competences that manufacturers, technology suppliers and installers should hand over to their final industrial users.

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1. Introduction

Improved energy efficiency has been considered as a major contributor both for European industrial competitiveness as well as environmental issues [1]. As recently pointed out, actions should be devoted to increase the energy efficiency of Small and Medium-sized Enterprises (SMEs), that represent the backbone of the European economy, are responsible of a major part of energy consumption, and are less

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efficient than larger enterprises [2]. In fact, despite the need for increased industrial energy efficiency, several studies indicate that cost-effective energy efficiency measures are not always implemented, which is explained by the existence of barriers to energy efficiency [3-5], as recently modelled by Cagno et al. [6]. Moreover, literature is starting providing contributions modelling the so-called driving forces: for most recent contributions, see e.g. Trianni et al. [7] and Cagno and Trianni [8]. Nonetheless, very few studies are providing empirical insights in the analysis of barriers and driving forces within the decision-making process of undertaking an investment for increased energy efficiency [5-6,8,9]. Pieces of empirical evidence here would help industrial decision-makers as well as policy-makers in order to understand where difficulties are rooted, how to overcome the barriers, which steps of the decision-making process are most critical, and who could best support enterprises, thus representing a preliminary basis for the development of the most effective policies for energy efficiency.

2. Research Methods

To do so, we have performed an exploratory investigation with interviews in 64 manufacturing SMEs located within the Pavia province in the Lombardy region, the wealthiest and most industrialized Italian region. The investigation has been focused on two relevant manufacturing activities in the Pavia province, namely: manufacture of fabricated metal products (C25) and manufacture of machinery and equipment (C28). The analysis has also been performed differentiating firm by sector, size (10-99 vs. 100-249 employees [10]) and energy intensity (energy costs higher or lower than 3% of production costs). The results were obtained through interviews conducted with owners, managers or other key people knowledgeable and responsible of investments in energy-efficient technologies and practices. The protocol of the investigation is as follows: firstly, the respondents have been asked to report relevant information about their business characteristics such as size, turnover, energy costs. Secondly, several information related to their attitude on investing in technologies for improved energy efficiency have been asked. Thirdly, the interviewees have been asked about the barriers, divided into macro-areas, the drivers, as well as the most critical steps of the decision-making process. The answers have been here ranked on an even Likert scale from 1 (minimum) to 4 (maximum). Finally, we asked the respondents who should best support them on the different drivers, as well as which energy management practices they adopt.

3. Results and conclusions

The investigation has provided several insights on energy efficiency issues to be addressed by industrial decision-makers as well as policy-makers. In fact, only 37.5% of the interviewees took advantage of an external expert consultant and about 40% of the sample carried out an energy audit in the last four years. Despite the declared interest in energy efficiency issues, such results seem to highlight that energy efficiency has not received proper attention. Furthermore, limited to the last four years, only 40.6% of enterprises conducted interventions in energy efficiency, and just 30% benefited of the existing subsidies. The study highlighted the relevance of economic barriers, with capital availability perceived as the most critical issue (Table 1), confirming previous research [3-5; 11]. Just after economic issues, we could find information-related barriers. In particular, during the interviews, despite the large availability of information about new technologies, new regulations or financial subsidies, enterprises highlighted in particular the form of the information provided, perceived as quite complicated, fragmented or not trustworthy, especially that coming from governmental and financial institution [3]. Lower importance has been attributed to competences and technology-related barriers. The analysis by firm size has provided interesting results: in fact, smaller enterprises highlighted greater barriers, in particular related to the lack of personnel and expertise regarding energy efficiency issues [3]. Whilst the distinction by sector

does not provide evidence of differences, the distinction between energy intensive and non-intensive activities emerges when considering the responses to the awareness barriers, with greater difficulties suffered by non-energy-intensive enterprises, that limit their focus strictly on production-related issues.

Table 1 Barriers to energy efficiency by category

	<i>Score</i>				<i>Average</i>	<i>Standard deviation</i>
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>		
Economic			16	48	3.75	0.44
Information	2	25	29	8	2.70	0.75
Organizational	1	22	36	5	2.66	0.62
Behavioral	1	35	21	7	2.58	0.71
Awareness	1	30	33		2.50	0.54
Competences		40	23	1	2.36	0.48
Technology-related	3	50	11		2.11	0.44

Barriers mostly affect the first steps of the decision-making process, and in particular the opportunity identification, followed by the generation of the awareness, the technology identification and planning of the intervention, in contrast with from previous literature [5]. In fact, lower importance is given to the last and most operative steps (financial analysis and installation, start-up, training), with the exception of smaller enterprises that highlighted major difficulties in the effective implementation of an intervention. Such difference might find explanation in the lack of expertise and competences of smaller enterprises. Economic drivers are deemed to be the most important [7], partially reflecting the perceived barriers, as shown in Table 2. Moreover, enterprises believe that external drivers are more important than internal ones. In fact, despite the existence of many internal drivers, enterprises pointed out the need of external support, which is perceived as crucial for their survival, considering the present economic crisis. The analysis of drivers on barriers has shown interesting patterns barriers-drivers, and very low correlation coefficients.

Table 2 Drivers to energy efficiency by category

	<i>Score</i>				<i>Average</i>	<i>Standard deviation</i>
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>		
Regulatory internal	1	17	35	11	2.86	0.70
Regulatory external		2	50	12	3.16	0.44
Economic internal		1	21	42	3.64	0.52
Economic external			18	46	3.72	0.45
Informative internal		34	21	9	2.61	0.73
Informative external		5	45	14	3.14	0.53
Vocational training internal	1	31	28	4	2.55	0.64
Vocational training external		6	50	8	3.03	0.47

It is furthermore noteworthy the relevance of governmental as well as financial institutions (Table 3). Indeed, as major actors responsible for financial as well as information-related drivers, their role is perceived as crucial by enterprises. Moreover, enterprises highlighted the need by governmental institutions to extensively simplify the bureaucratic process behind an investment in energy efficiency. Moreover, several enterprises highlighted the relevance of manufacturers as well as technology suppliers in fostering drivers related to the vocational training [12]. Lastly, several insights for policy-makers can be obtained by the analysis of several energy management practices. In fact, basic practices as the determination of priorities for capital investment, the analysis of data sheet and equipment specification, as well as programs of staff training and increased awareness are considered not important. Nonetheless,

the monitoring of the energy use and costs, programs to stimulate and sustain interest reach a certain importance among the interviewees. Moreover, the simple pay back criteria was deemed as the most widely use practice to evaluate energy efficiency investments, thus showing their limited capability to properly evaluate investments. Such results show that much greater efforts should be devoted in fostering the adoption of energy management practices.

Table 3 Actors promoting the different drivers by category.

<i>Actors</i>	<i>Drivers</i>			
	<i>Regulatory</i>	<i>Economic</i>	<i>Informative</i>	<i>Vocational training</i>
Government	62	45	4	
Energy suppliers	18	3	38	1
Manufacturers	13	1	27	15
Technology suppliers	10	2	30	38
Installers		1	1	26
Financial institutions	4	53	5	
ESCOs	5	22	10	2
IAGs	1	1	3	
Clients	4		3	
Competitors	1	1	2	
Allies		2	7	

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